



Centrality determination in eA collision using forward neutron based on BeAGLE

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2019.09.04

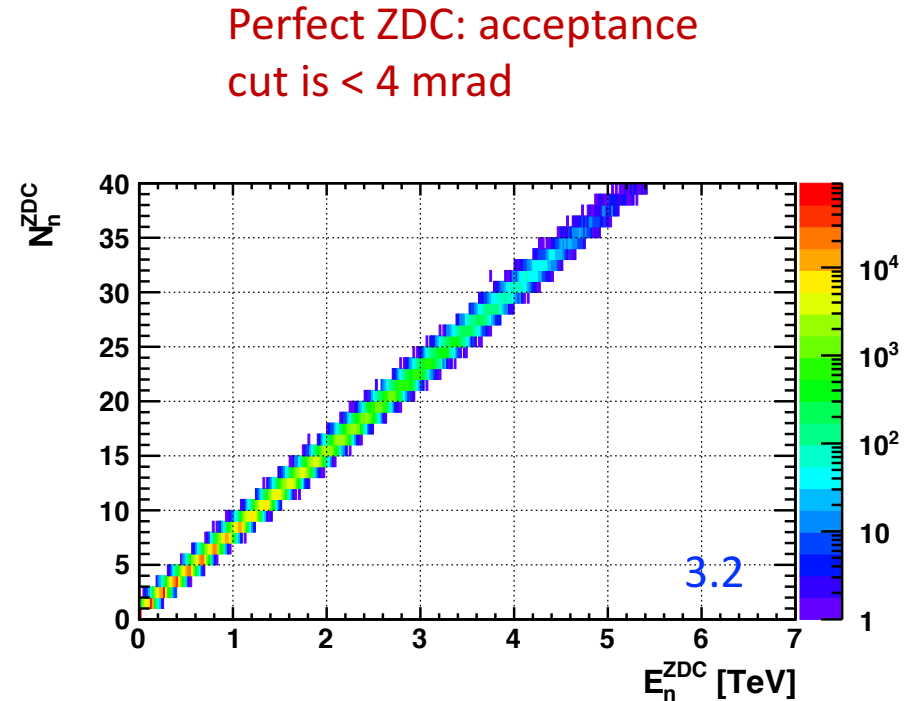
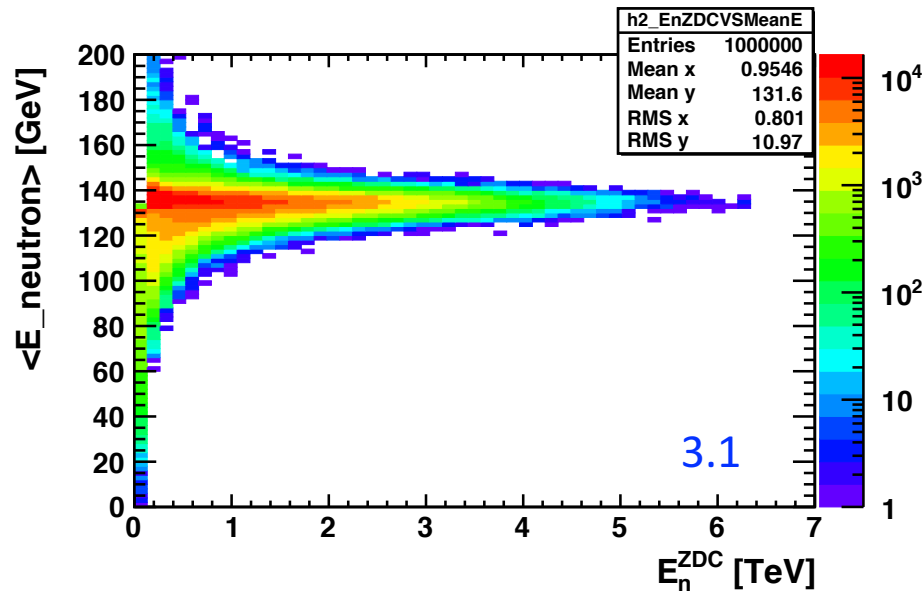


- ❑ Input files live under:

/eicdata/eic0002/wanchang/BeAGLE_Centrality/Shd3_tau9

- ❑ ePb_1M_Sh3_tau9_kt=ptfrag=0.32_noquench_US1.inp
- ❑ eAS3noq
- ❑ 18x135 ePb collisions. No quenching.
- ❑ $0.01 < y < 0.95$, $1 < Q^2 < 100 \text{ GeV}^2$
- ❑ $\tau_0 = 9 \text{ fm/c}$, genShd=3
- ❑ nPDF: EPS09LO (proton PDF: CTEQ6L1) proton PDF: CTEQ6L1
- ❑ 1M events

Original distribution



E_n^{ZDC} : generated energy deposited in ZDC

$\langle E_{\text{neutron}} \rangle$: mean energy of neutron in ZDC

N_n^{ZDC} : number of neutron in ZDC

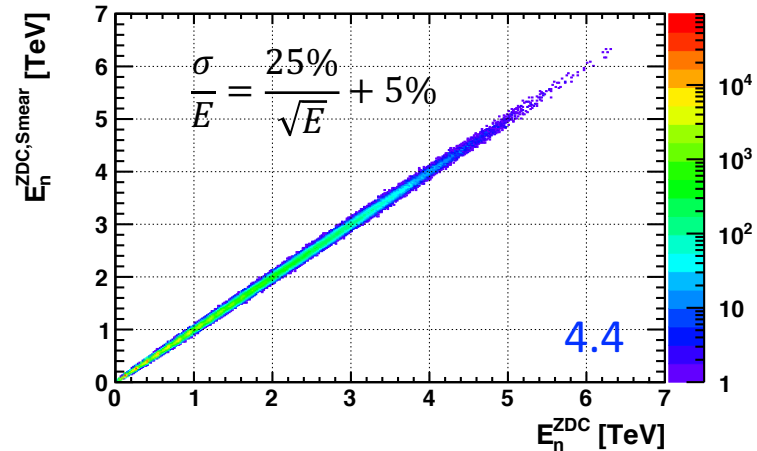
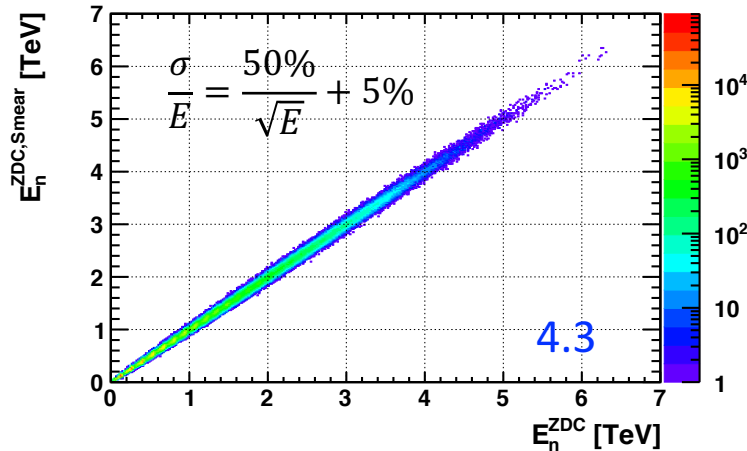
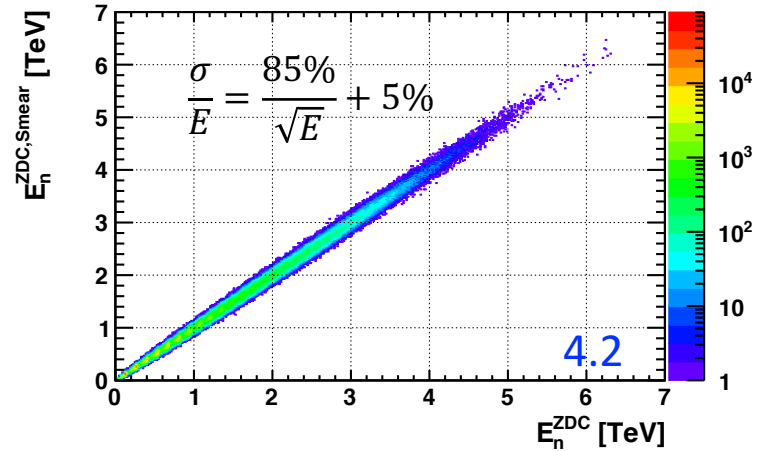
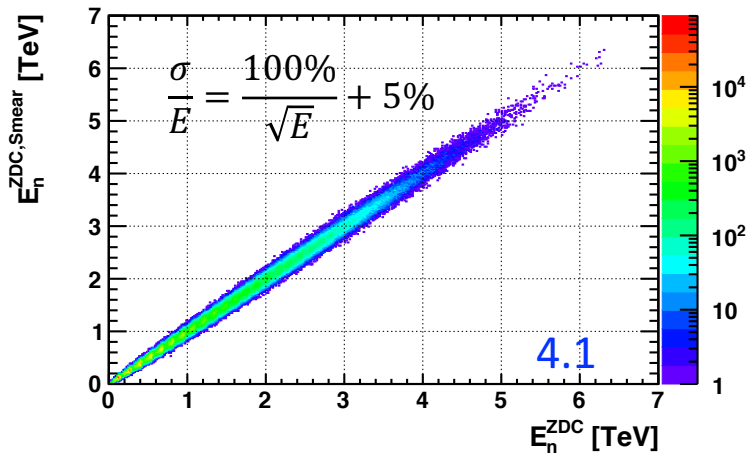
In most of events, the mean energy of neutron in ZDC is approximately equal to beam energy.

E_n^{ZDC} VS. $E_n^{ZDC,Smear}$ with different energy resolution

E_n^{ZDC} : energy deposited in ZDC

$E_n^{ZDC,Smear}$: smeared energy deposited in ZDC

Perfect ZDC: acceptance cut is < 4 mrad

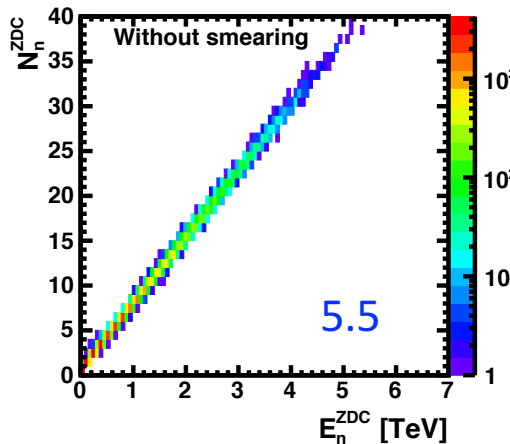
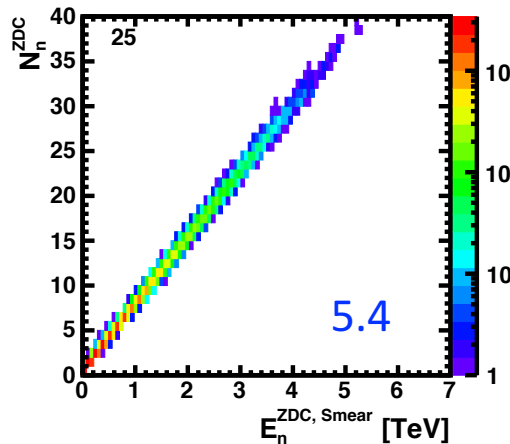
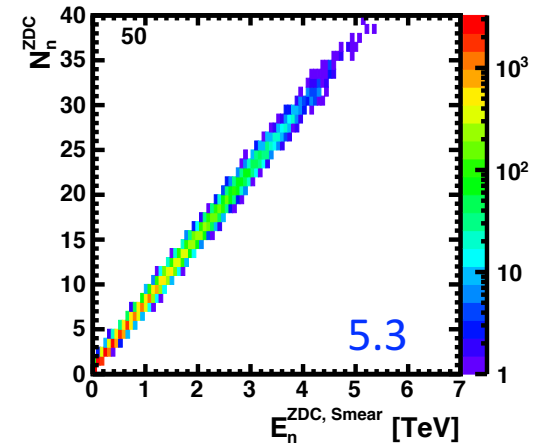
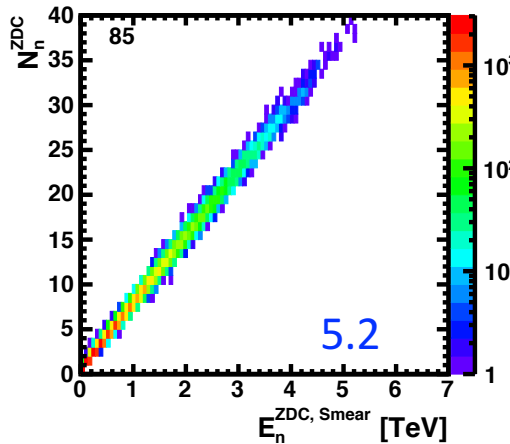
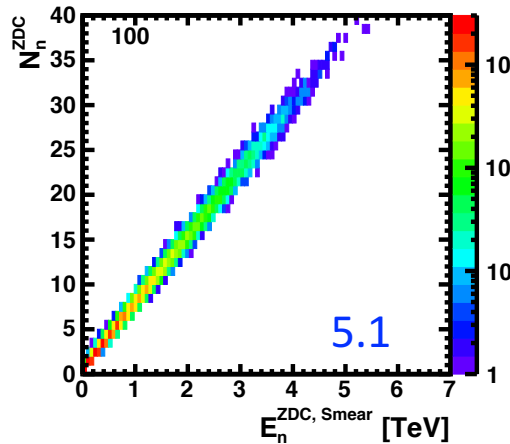


$E_n^{ZDC, Smear}$ vs. N_n^{ZDC} with different energy resolution

$E_n^{ZDC, Smear}$: smeared energy deposited in ZDC

N_n^{ZDC} : the number of neutrons in ZDC

40K events



$$\frac{\sigma}{E} = \frac{par\%}{\sqrt{E}} + 5\%$$

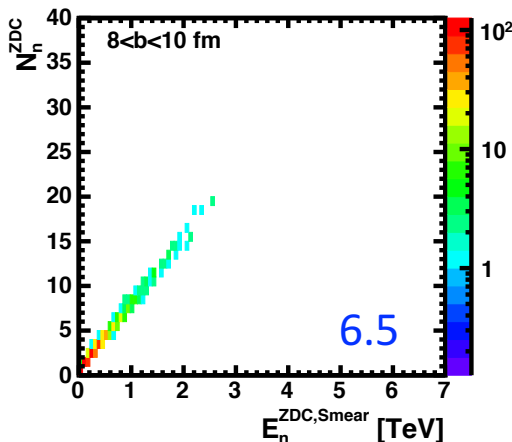
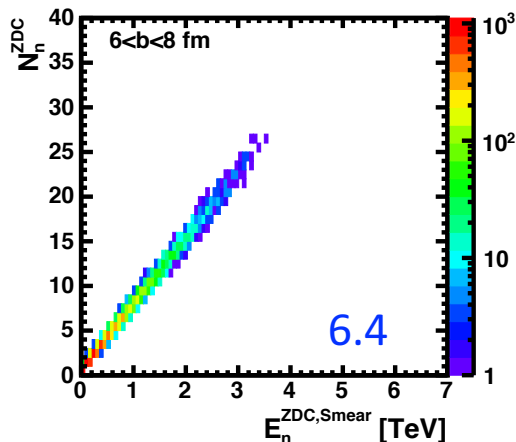
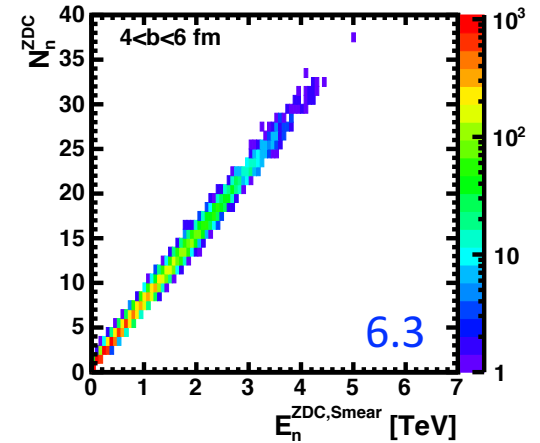
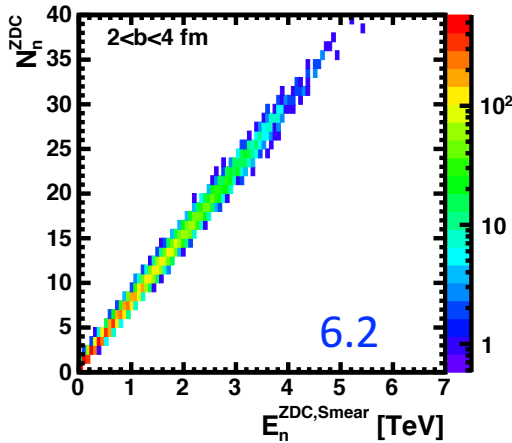
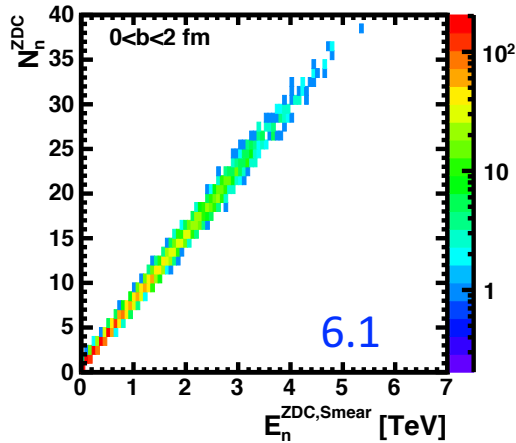
$$par=100, 85, 50, 25$$

$E_n^{ZDC,Smear}$ VS. N_n^{ZDC}

Energy resolution: $\frac{\sigma}{E} = \frac{100\%}{\sqrt{E}} + 5\%$

40K events

The correlation of $E_n^{ZDC,Smear}$ and N_n^{ZDC} for five slices in b: 0-2, 2-4, 4-6, 6-8, 8-10



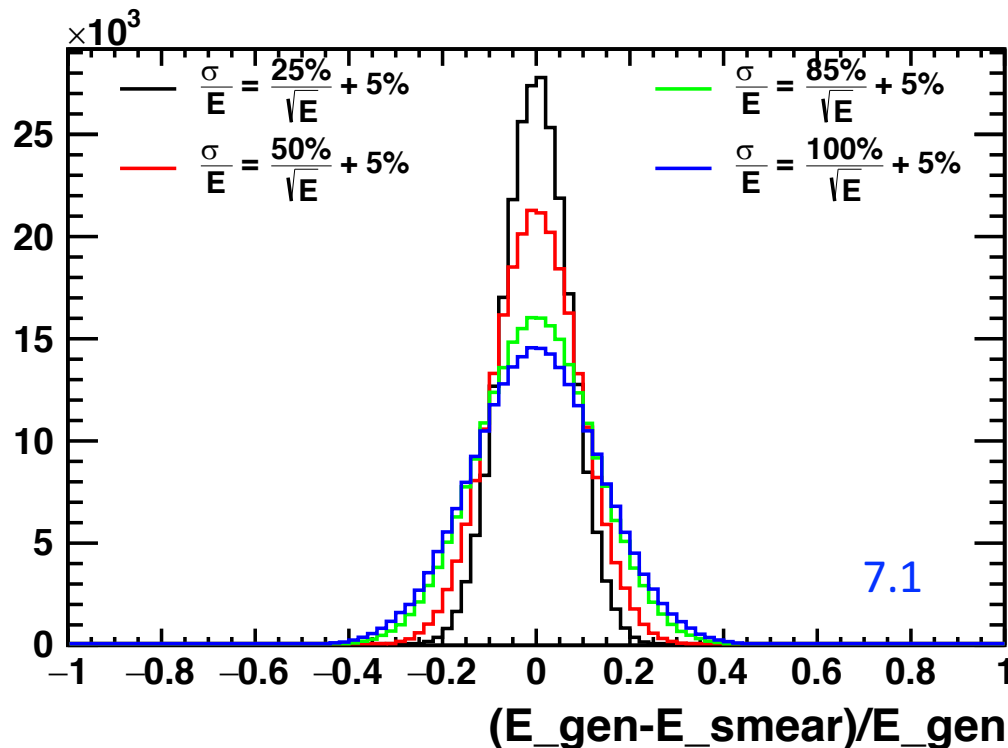
$$\frac{\sigma}{E} = \frac{100\%}{\sqrt{E}} + 5\%$$

E_gen - E_smeared/E_Gen

Energy = particle->E; (E_gen)

Sigma100 = (1./TMath::Sqrt(Energy) + 0.05)*Energy; (resolution sigma)

EnergySmear100 = gRandom->Gaus(Energy, Sigma100); (E_smear)

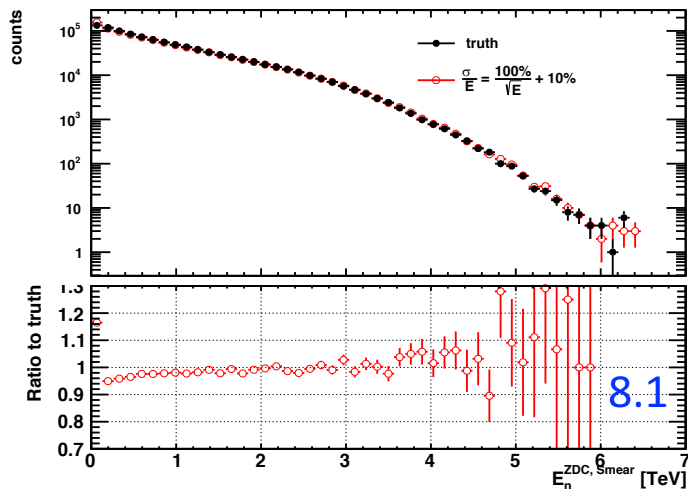


40K events

The width of these plots:

	Width
$\sigma = (\frac{1}{\sqrt{E}} + 5\%)*E$	0.1373
$\sigma = (\frac{0.85}{\sqrt{E}} + 5\%)*E$	0.1243
$\sigma = (\frac{0.50}{\sqrt{E}} + 5\%)*E$	0.09354
$\sigma = (\frac{0.25}{\sqrt{E}} + 5\%)*E$	0.07162

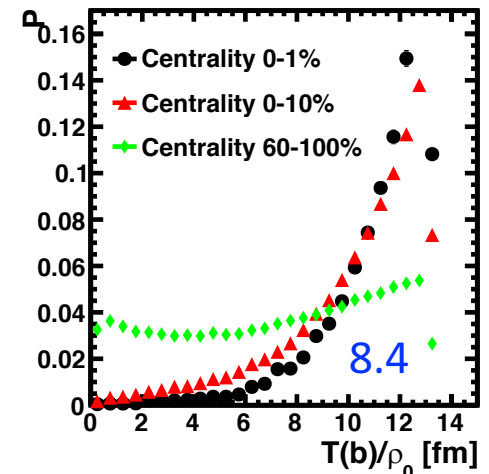
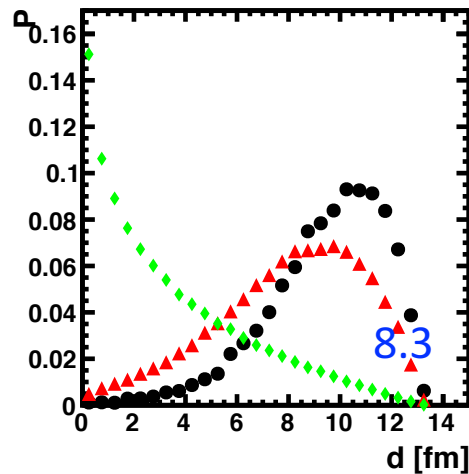
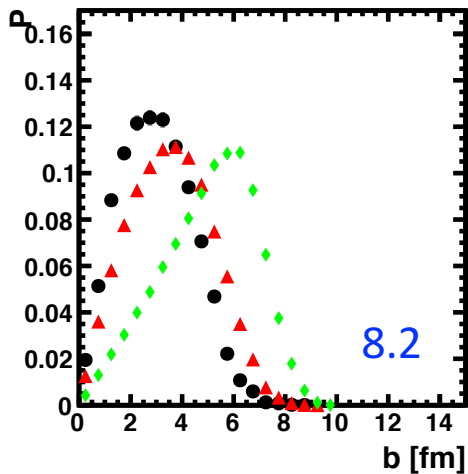
Energy deposition distribution



The distribution of energy deposition for the truth and smearing with an energy resolution: $\frac{\sigma}{E} = \frac{100\%}{\sqrt{E}} + 10\%$

- Do smear to each individual neutron with a gaussian which has a width of the resolution.

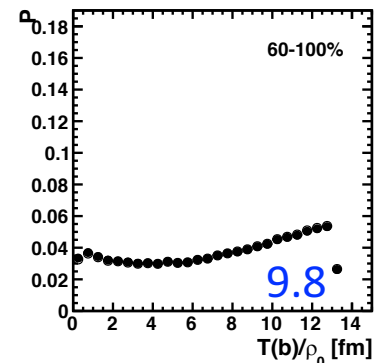
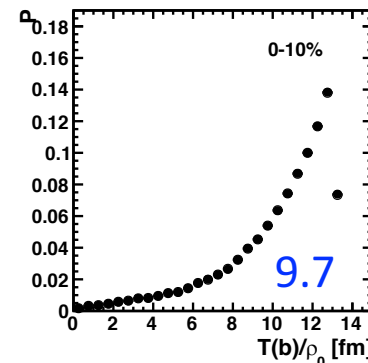
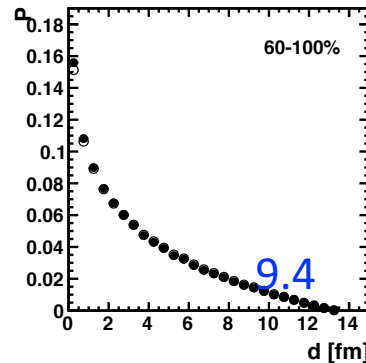
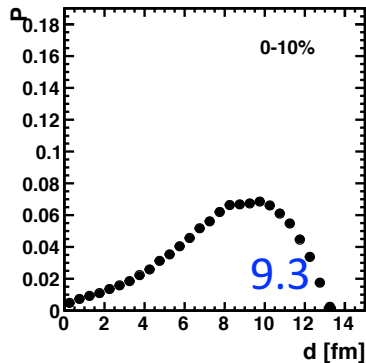
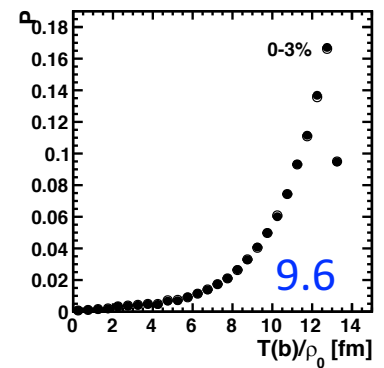
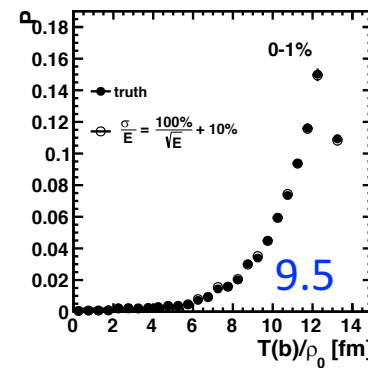
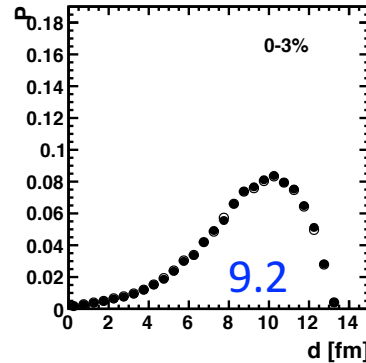
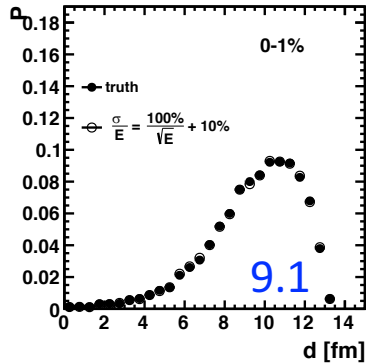
The centrality dependence of impact parameter b , traveling length d , nuclear thickness $T(b)/\rho_0$



Smear by resolution: $\frac{\sigma}{E} = \frac{100\%}{\sqrt{E}} + 10\%$

Centrality dependence

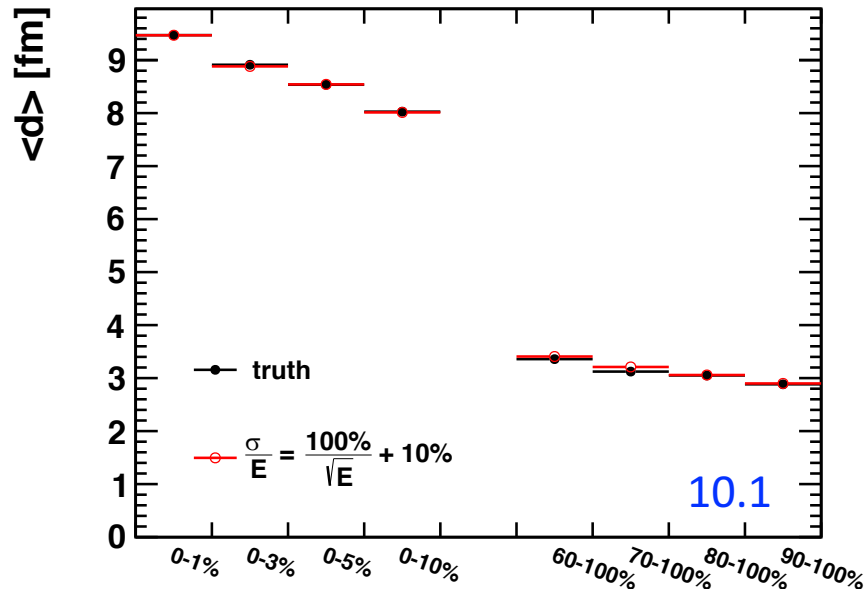
The comparison of truth and smearing with worst resolution in different centrality bins: 0-1%, 0-3%, 0-10%, 60-100%



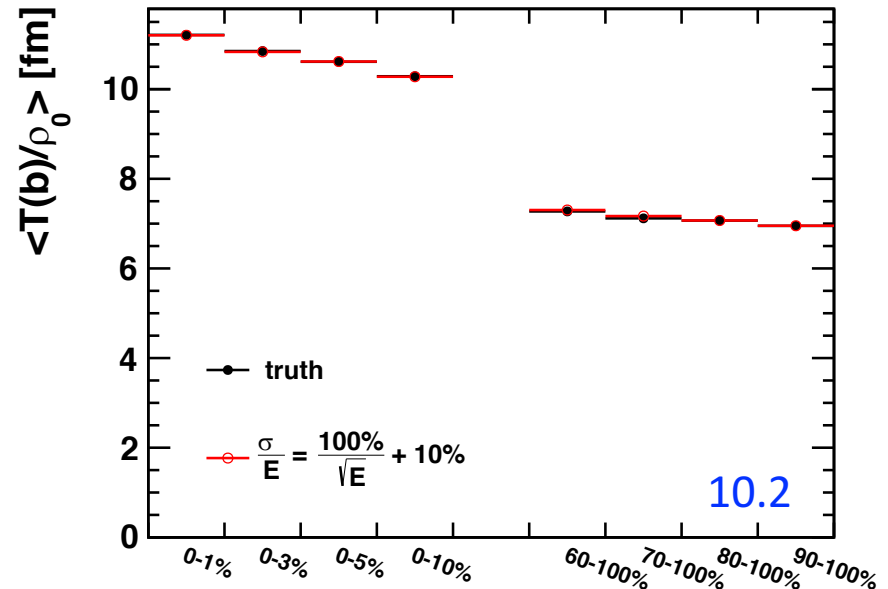
- The distribution of truth and smearing are identical.
- Making a very good calorimeter does no matter. A better calorimeter won't help.

Centrality dependence

The average value of traveling length d in different centrality bins:

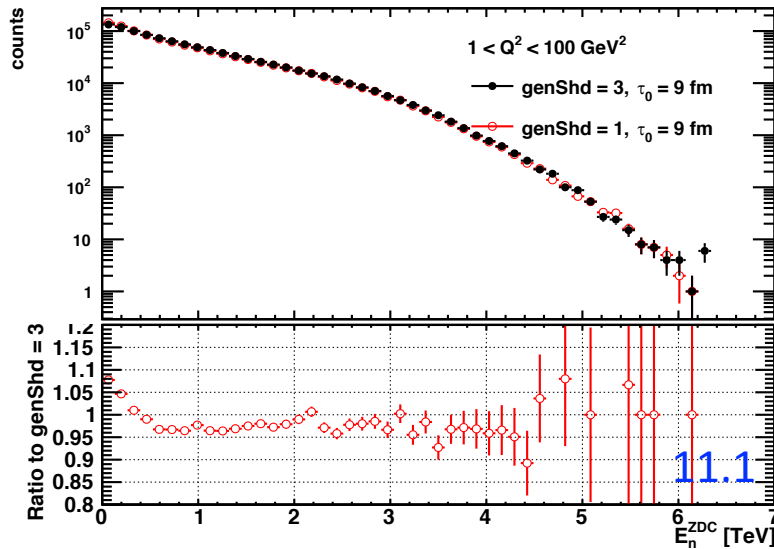


The average value of nuclear thickness $T(b)/\rho_0$ in different centrality bins :

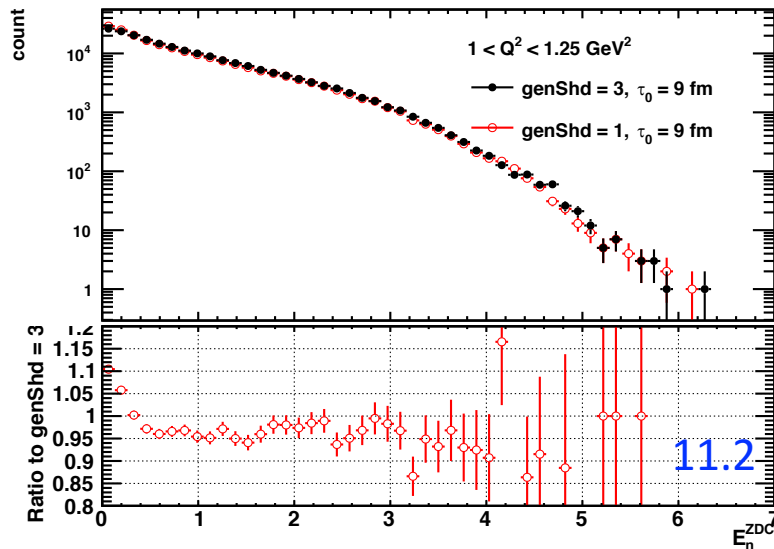


- They are almost identical for the two cases.
- The average decreases from 0-1%, 0-3% to 0-5%, 0-10%
- The decreasing trend is not obvious in peripheral collisions(60-100%, 70-100%, 80-100%, 90-100%) for each case.

genShd = 3 VS. genShd = 1(truth)

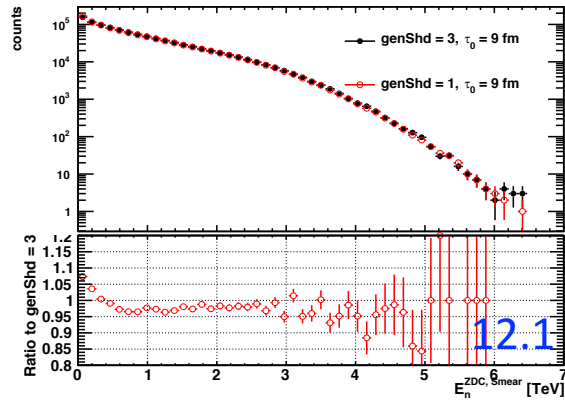


For all of events

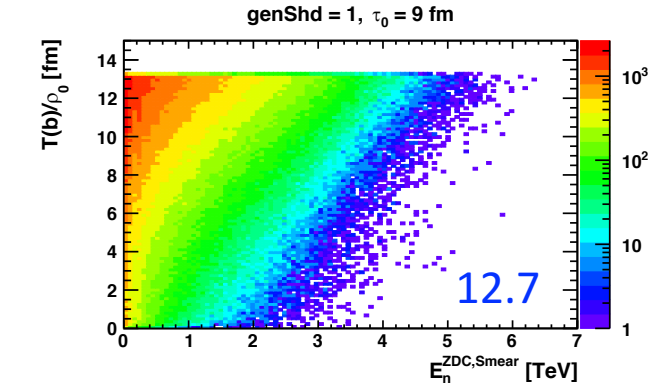
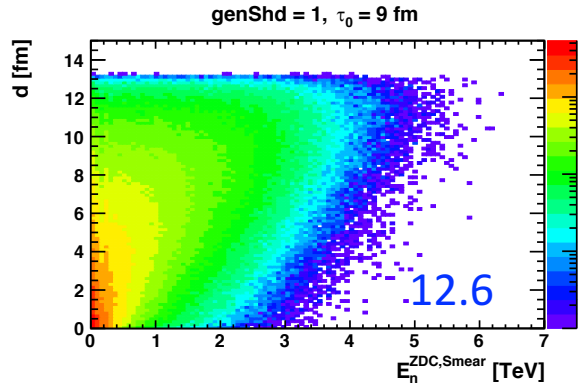
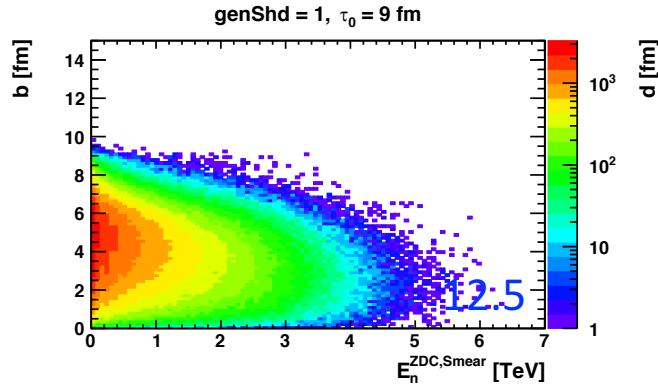
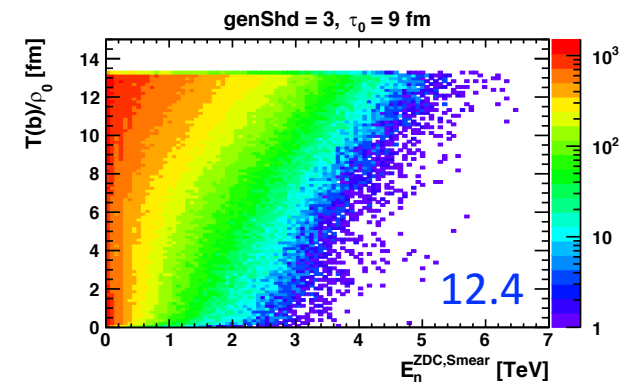
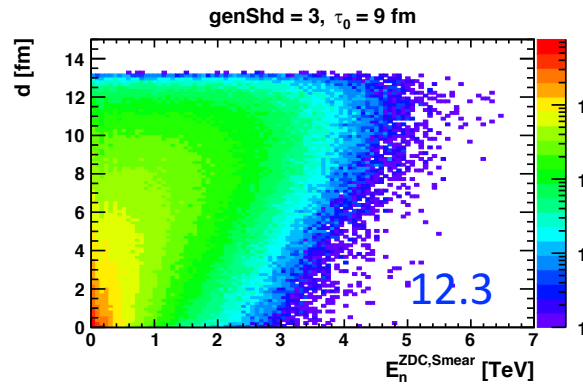
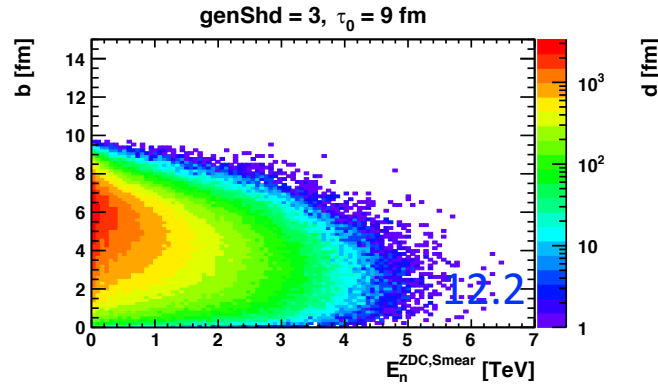


For the ~20% of events
with the lowest Q^2 :
 $1 < Q^2 < 1.25 \text{ GeV}$

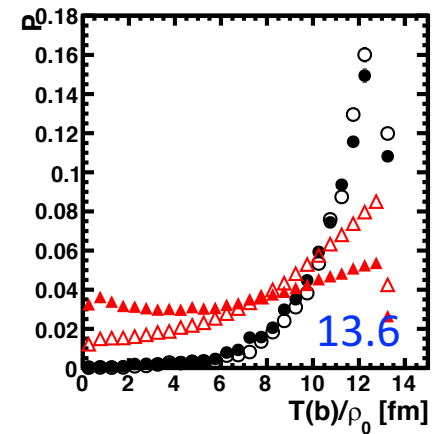
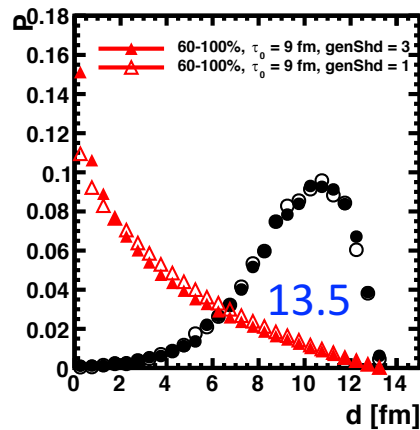
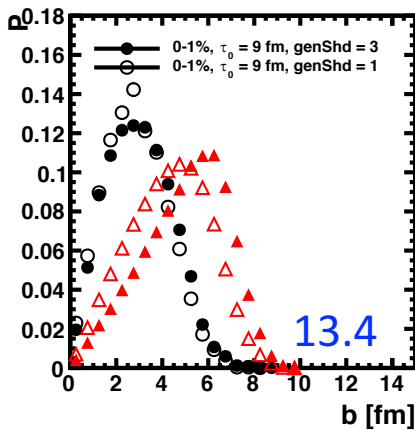
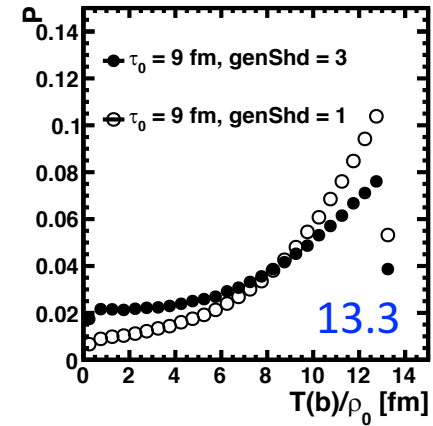
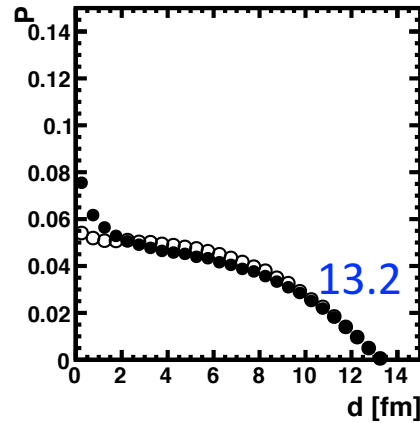
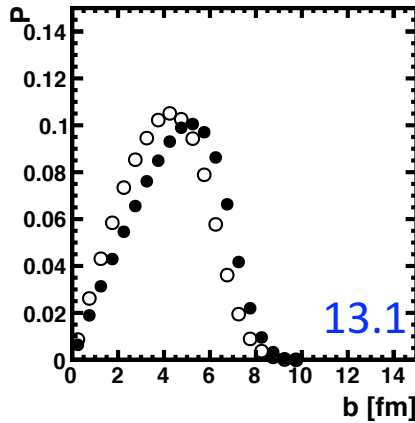
genShd=3 VS. genShd=1



Smear by resolution: $\frac{\sigma}{E} = \frac{100\%}{\sqrt{E}} + 10\%$

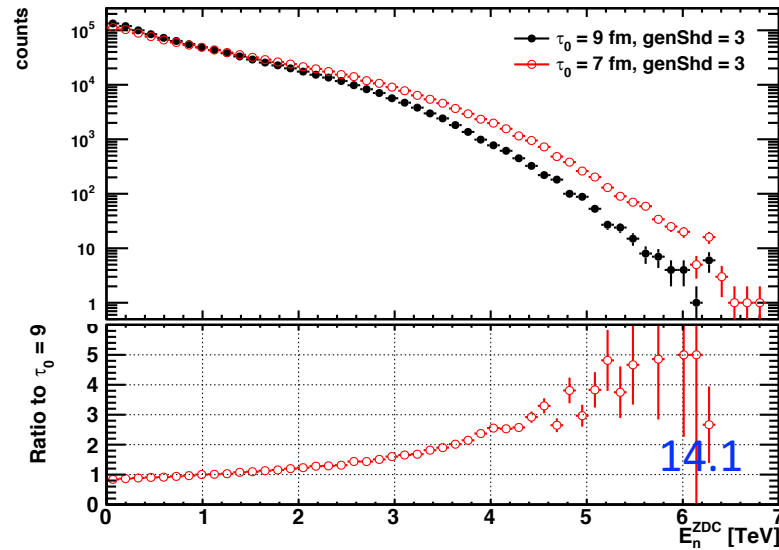


genShd=3 VS. genShd=1

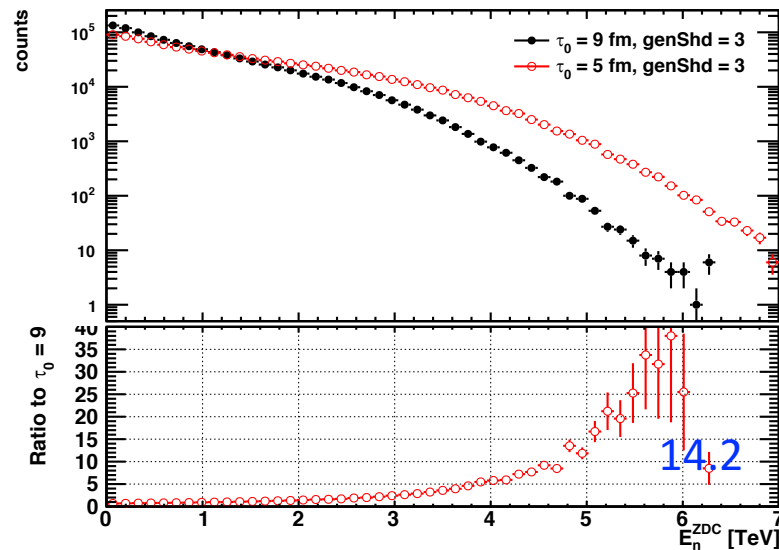


The comparison of genShd=3 and genShd=1. The influence is mainly concentrated in the peripheral collision

$\tau_0 = 9$ fm VS. $\tau_0 = 7$ fm & $\tau_0 = 5$ fm (truth)

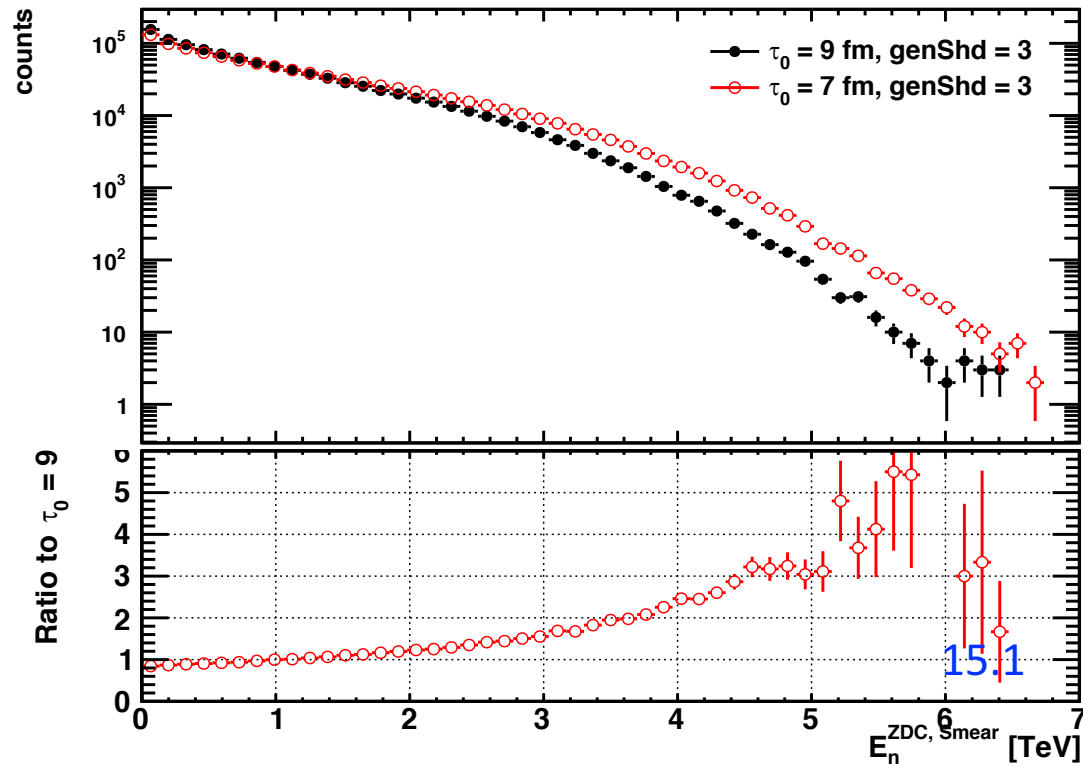


$\tau_0 = 9$ fm VS. $\tau_0 = 7$ fm



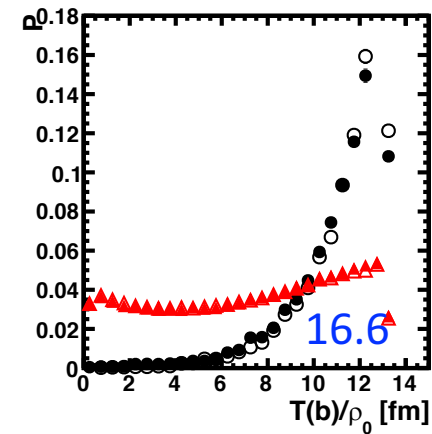
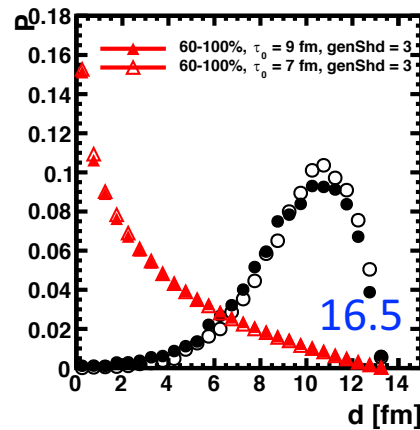
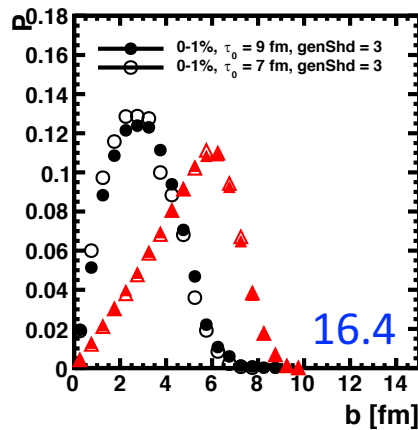
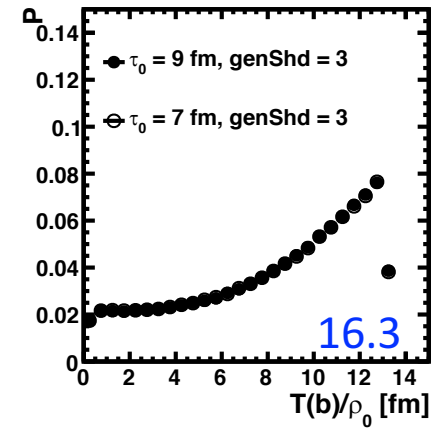
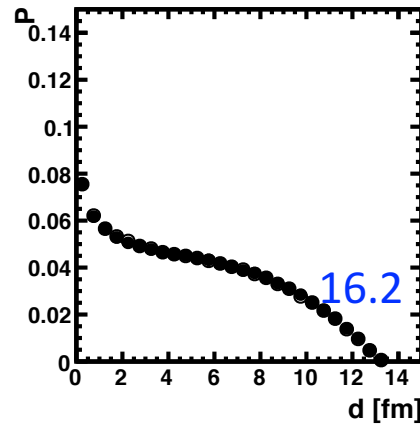
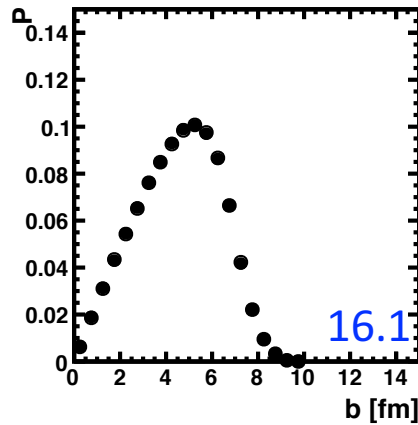
$\tau_0 = 9$ fm VS. $\tau_0 = 5$ fm

$\tau_0 = 9$ VS. $\tau_0 = 7$



Smear by resolution: $\frac{\sigma}{E} = \frac{100\%}{\sqrt{E}} + 10\%$

$$\tau_0 = 9 \text{ VS. } \tau_0 = 7$$



No dependence on τ_0